

Capture-recapture Method for Estimating Completeness of Disease Surveillance

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Identifying all the cases of a disease or medical condition is important when measuring the associated health and economic impacts and evaluating the quality of a surveillance system. Using multiple surveillance systems allows public health agencies to find all of the cases that occur. The capture-recapture method provides a way to assess completeness of our disease surveillance systems and more completely measure the impact of a disease.

Discussion Points

Here are three discussion points related to the capture-recapture method. The answers are contained in the text, or you may refer to answers at the end of this article.

1. Describe the capture-recapture method.
2. What data systems are available to compare when evaluating disease surveillance?
3. In 2009, 100 cases of Disease A are found in a death certificate review among residents of a state. 80 fatal cases of Disease A are found in hospital abstract summaries from the state's hospitals during the same time period. 70 people are found in both systems. Which of the following statements are true:
 - a. There are an estimated 180 cases of Disease A in the state.
 - b. Both systems have the same estimated level of completeness.
 - c. Death certificate review is a better method than hospital abstracts for finding fatal cases of Disease A.

Capture-recapture methodology

The capture-recapture method (also called "mark and recapture") was originally developed in the field of ecology to estimate the size of animal populations. In ecological studies, the researcher captures, physically marks, and releases animals from a population. On a different day, the researcher returns to capture animals from the same population.

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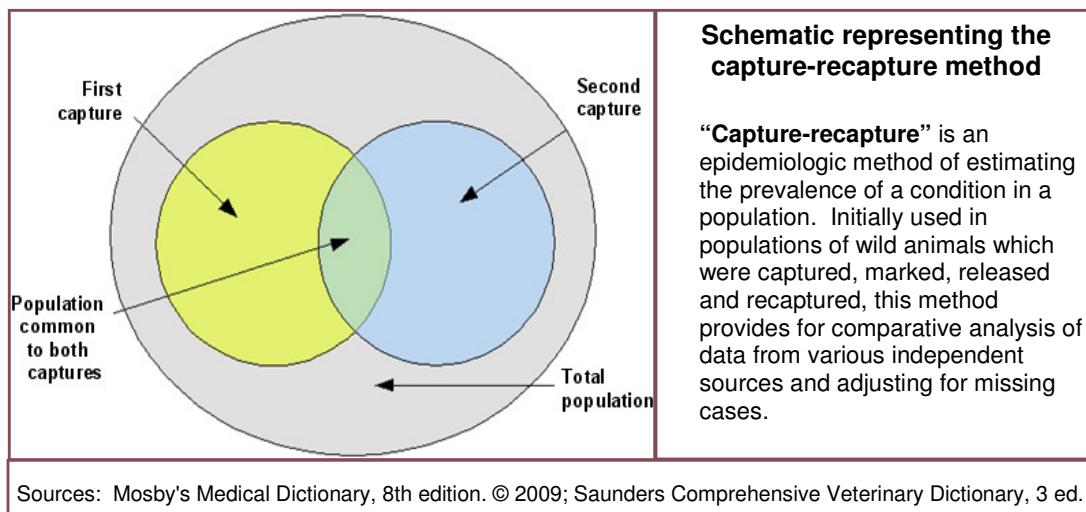


*epi*Trends
P.O. Box 47812
Olympia, WA 98504-7812

Mary C. Selecky
Secretary
Maxine Hayes, MD, MPH
State Health Officer
Anthony Marfin, MD, MPH, MA
State Epidemiologist
Communicable Disease
Marcia J. Goldoft, MD, MPH
Scientific Editor
Deborah Todd, RN, MPH
Managing Editor

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Based on the number of animals captured the first time, the number captured the second time, and the number captured both times (determined by the marking), the total animal population size can be estimated. For example, if most animals from the second capturing period are already marked (i.e., recaptured), this suggests that most of the population was captured during the first period and that there are few uncaptured or unknown animals in the population. Conversely, if many unmarked animals are found during a second capture period, it suggests that the population is much larger than the number of animals captured.



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An Applied Example

We applied this method to the problem of determining how many cases of invasive listeriosis truly occurred in Washington State during the years 1994 – 2009.

Listeriosis generally occurs when a person consumes a food product contaminated with *Listeria monocytogenes*, bacteria that can move from the digestive tract to the blood and other body tissues and cause meningitis, sepsis, or other severe infections. Listeriosis is considered invasive when *Listeria* is isolated from the blood, cerebral spinal fluid (CSF), or normally sterile tissue. Because most invasive cases occur in newborn infants, pregnant women, or elderly people and illnesses are usually severe enough to require hospitalization, we presumed that the Washington State Department of Health (DOH) receives notice of most listeriosis cases via required reporting from healthcare providers, healthcare facilities, and laboratories to local public health jurisdictions.

Most invasive listeriosis cases should be noted in three separate systems commonly used for disease surveillance -- the Public Health Issues Management System (PHIMS), the Comprehensive Hospital Abstract Reporting System (CHARS), and

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death certificates. PHIMS includes those listeriosis cases reported by providers, facilities or labs that are then entered by local health jurisdictions as notifiable conditions. Because PHIMS is dependent on this two-step process, there has always been concern that cases are underreported. CHARS is a system that collects information on all inpatient admissions in all non-military hospitals in Washington State by abstracting data from billing records including the discharge diagnoses. This system provides good information on the volume of hospital admissions across the state, but may not capture complete information on the medical conditions present during the hospital admission. CHARS data are regularly de-duplicated to remove re-admissions for an individual for the same illness.

To study listeriosis reporting, we used data from PHIMS and CHARS to estimate the total number of people with invasive listeriosis. From this estimated total number of cases, we determined how completely each surveillance system was detecting cases of the disease. With this information, we can work toward improving these surveillance systems.

Invasive listeriosis in Washington State, 1994 – 2009

In Washington, from 1994 to 2009, 241 hospitalized cases of invasive listeriosis were reported to PHIMS. During this same period, 214 hospitalizations with an ICD9 billing code for *Listeria* infection were present in CHARS data. Finally, we identified people who were present in both PHIMS and CHARS using basic identifying information available in each system (patient name or partial name, date of birth, and home zip code); 156 patients were present in both systems.

The following formula was used to estimate the total number of cases in the population during this 16-year time period*:

$$\frac{(\# \text{ captured by system A}) \times (\# \text{ captured by system B})}{(\# \text{ captured by both systems})} = \text{Total \# of cases}$$

* Tilling, K. Capture-recapture methods – useful or misleading? *Int Epi Assoc* 2001;30:12-14.

Applying this formula to the listeriosis investigation yields the following:

	Patients in PHIMS	Patients not in PHIMS	
Patients in CHARS	156 Detected by both	58 Detected by CHARS only	214 “Captured” in CHARS
Patients not in CHARS	85 Detected by PHIMS only	31 Missed by both**	
	241 “Captured” in PHIMS		330 Estimated total cases

** Estimated number of persons not present in either CHARS or PHIMS

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Neither PHIMS nor CHARS captured 100% of invasive listeriosis cases requiring hospitalization. Of the estimated 330 total cases that are likely occurring, PHIMS identified 241 (73%) and CHARS identified 214 (65%).

Because PHIMS is the primary data management system for conditions of public health interest, determining its completeness is important. Specifically, for invasive listeriosis, we now know there are cases of severe food-borne illness occurring that do not come to the attention of DOH through PHIMS. In addition, we now know that previous estimates of the impact of invasive listeriosis using PHIMS underestimate the number of invasive listeriosis cases by about 25%. Further analyses will be done to determine characteristics of people identified in CHARS but not PHIMS to identify if a subgroup of cases is systematically underreported. In addition, a similar capture-recapture analysis will be done with death certificates to determine if cases that are missed in PHIMS and CHARS are present in death certificate data and if a more complete dataset can be assembled using data from all three systems.

We are continually pursuing ways to improve completeness and accuracy of surveillance. The completeness of surveillance is likely to improve as we implement the revised notifiable conditions reporting rule in 2011 and move towards electronic laboratory reporting. Both of these changes are expected to improve case ascertainment and allow a better measure of disease incidence and the impact of these diseases on Washington State. The use of capture-recapture methods is one way that the quality of a surveillance system can be continuously evaluated.

Answer to Public Health Discussion Points

1. The capture-recapture method is used in animal studies to estimate the size of a population by comparing the number of animals captured in two independent collection periods. In public health, cases are “captured” in two independent surveillance systems. Some cases are present in both systems but some cases may only be found in only one of the systems. These findings are then used to estimate the true number of cases in a population.
2. This investigation compared notifiable conditions reporting of hospitalized listeriosis cases to listeriosis cases identified in hospitalization discharge summaries. Other potential sources of public health data for this type of study include death certificates, emergency department records, prescriptions, laboratory reports, and disease registries.
3. The correct answer is “c.” Using the formula above, we estimate there were 114 total fatal cases of Disease A in the state. Death certificates identified 100 of the estimated 114, or 88%. Reviewing hospital discharge abstracts identified 80 of the estimated 114, or 70%. Of course, there are other characteristics that should be considered such as timeliness when considering which surveillance system suits your purposes best.

If you have any questions or comments specifically about this article, please contact authors Tracy Sandifer, MPH, or Marcia Goldoft, MD, MPH, at Communicable Disease Epidemiology Section (206.418.5500), Washington State Department of Health.